DESIGN AND DEVELOPMENT OF A WIRELESS INDOOR SMART ENERGY SAVING AND MONITORING SYSTEM

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MASTER OF SCIENCE

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in fulfillment of the requirements
for the award of the degree of
Master of Science

Faculty of Engineering Technology
UNIVERSITI MALAYSIA PAHANG

MAY 2019

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to the supervisory committee Dr. Hadi Manap for his continuing encouragements and constant support towards this research. Special gratitude also goes to Dr. Yasir H. Naif for his continuing support, professional guidance and leads me how to involve in a research to perform a high quality and professional work.

My sincere thanks go to all my laboratory members of the staff of Engineering Technology Department, UMP, who helped and supported me in many ways to bring the successfulness of making this research. Sincere thanks also go to Institute of Postgraduate Student in Universiti Malaysia Pahang (UMP), for the PGRS scholarship.

Special gratitude also goes to my parents and my family members, who always give me moral and financially support all the time to make this research successful. I would not able to complete this research without all the helps.

At last but not the least, I would like to thank all my friends who give me support all the time when conduct this research.

ABSTRAK

Sistem Pintar atau Automasi Rumah telah menjadi terkenal dan pelbagai teknologi yang baharu. Sesetengah Sistem Pintar yang telah berubah mempunyai kualiti yang lebih baik dan pasaran yang hangat. Pengubahsuaian pada bangunan di tempat kerja sedia ada ialah satu idea dan cara untuk memudahkan Sistem Pintar digunakan di mana-mana tempat terutamanya di Malaysia. Penyelidikan ini menerangkan sistem yang berubah menjadi suasana tempat kerja yang lebih pintar. Sistem Pintar yang deperkenalkan ini boleh menyimpan tenaga. Kini, melalui analisis trend menunjukkan kegunaan bekalan elektrik semakin meningkat pada masyarakat ini. Isu kehilangan tenaga telah menjadi topik yang hangat. Selain itu, bahawa isu tersebut akan membawa impak yang besar dalam perhargaan elektrik yang meningkat serta kasilan kuasa yang menurun. Para pengguna tidak tahu sebab kehilangan tenaga. Dalam penyelidikan ini, sistem ini boleh mengurangkan pembaziran penggunaan kuasa di kawasan tempat kerja. Selain itu, sistem tersebut juga digunakan untuk mengawasi dan menganalisis kegunaan di setiap bilik pejabat di kawasan tempat kerja. Kebanyakan pengguna mencadangkan cara untuk mengubahsuai bangunan yang telah diwujudkan berbanding dengan membina bangunan yang baharu. Cara pengubahsuaian bangunan yang telah diwujudkan memerlukan kos yang lebih rendah dan mempunyai kualiti yang sama berbanding dengan bangunan yang baharu. Sesetengah pelengkapan asas yang berkos rendah dan mudah didapati telah digunakan untuk menghasilkan sistem tersebut supaya sistem ini dapat memaksimumkan penjimatan tenaga dengan kos yang paling minimum dalam kawasan tempat kerja. Pelbagai alatan yang digunakan termasuk alat pengawal yang diprogramkan, modul gabungan penerima dan pemancar, suis pengganti, sensor, dan lain-lain lagi untuk membina sistem tersebut. Sistem ini akan mengawal operasi peralatan elektrik yang berada di dalam tempat kerja. Sistem ini juga dibina dengan automasi dan tanpa wayar. Dalam konsep ini, sistem tersebut akan menghidupkan peralatan elektrik secara automatik jika ada sesiapa berada di dalam bilik pejabat. Sistem ini juga akan menutup peralatan elektrik jika tiada sesiapa di dalam bilik pejabat. Tambahan lagi, sistem ini mudah dialihkan ke mana-mana tempat. Konsep ini dapat menjimatkan tenaga di kawasan tempat kerja. Bahagian sistem pengawalan memainkan peranan yang penting untuk mengawasi suasana setiap bilik di kawasan tempat kerja dan juga mengawasi kehadiran setiap staf pada setiap masa. Sistem ini mempunyai teknologi yang canggih dan maju berbanding dengan sistem yang telah diwujudkan di pasaran. Di samping itu, sistem ini juga boleh membuat analisis data berkaitan dengan masa kerja setiap hari. Melalui analisis data sistem ini juga boleh menunjukkan perbezaan sebelum dan selepas digunakan di kawasan tempat kerja. Dalam keputusan perbandingan yang ditunjukan, aplikasi sistem amat sesuai digunakan di kawasan tempat kerja. Perkara yang harus diperhatikan semasa memasang sistem ini adalah lokasi yang sesuai, identiti pengguna yang sesuai, dan juga jangka masa untuk menggunakan sistem tersebut. Akhir sekali, dalam keputusan sistem ini, jumlah tenaga yang digunakan telah menurun. Sebagai contoh, jumlah tenaga yang digunakan di dewan telah berkurang sebanyak 18kWh. Sistem ini dapat menjimatkan 50%. Keputusan ini telah membuktikan system ini sesuai dan boleh digunakan oleh para pengguna di kawasan tempat kerja. Justeru, sistem ini telah mendapat pengiktirafan ramai dan mempunyai permintaan yang tinggi di dalam pasaran bagi menjadikan kehidupan manusia menjadi lebih selesa dengan menggunakan sistem yang berkos rendah dan kehidupan yang berkualiti.

ABSTRACT

Smart Homes or Home Automation becomes famous and different new technology begins to emerge recently. A number of improvements make Smart Home better quality and marketed to the public. To allow the Smart Home system more reliable to any places, modification of an existing work building becomes an idea in the society especially in Malaysia. This research describes a system to convert a conventional into an intelligent working area. A Smart System is introduced to reserve energy. Nowadays, the trends show that highly demand electricity in the society. The issue of rapid energy losses has been discussed around the corner. Energy losses bring the impact of soaring prices of electricity and power production reduces. All the consumers have no idea about the reasons of energy losses. In this research, the design of a wireless and reliable indoor smart power saving system is to minimize the energy losses for the work stations area. Not only have that, the system is able to monitor and analyse the power consumption specialised in each of sections in work building. Modification of an existing work building is highly recommended compare to rebuild a building. The cost is lower if apply a system in existing building and brings out an equivalent standard compare to a new building. Some basic equipment which easily to get and purchased with a lower price to produce the system and apply in the work area, to minimize the cost using and maximize the energy saving. A variety of equipment are used include a programmable controller, transceiver module, relay switches, sensors and others to build up the system. The system will control the operation of electrical appliances in work building based on the conditions of offices. The system works also in fully automated and wireless. When there is someone in the office room, the system will turn ON the appliances immediately. However, when there is no one in the office after certain time, the system will turn OFF the appliances. On top of that, the system is portable to use in anywhere. This concept brings the conveniences and easily to save the energy in any work building. The Monitoring System plays a role to monitor the condition of every office room in work building. This monitoring concept is able to detect the occupancy of the staff in real time during working hours. This shows that the valuable and more advances compare to the technology already in market in this research. Moreover, the system will make data analysis according to the results collected in daily working hour. The data analysis will shows the different between before and after the system is applied in work area. From the comparison results, the application of Smart Energy Saving and Monitoring System is reliable to be placed in work area. The requirement to install the system is according to different locations, different identity of user and the period of using the system. Lastly, the results showed that the total energy used was reduced. For example, the total energy used in lecturer hall had reduced 18kWh. A higher percentage of total energy estimated saves up to 50% was showed after the system was applied. The results proved that the system is applicable and reliable to the user in work area. Thus, this system takes into account the architecture of human cognition and it is highly demand in market to achieve a lower energy usage at the same with high quality and comfortable life.

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LIST OF SYMBOLS

GWh	Giga-watt hours
J	Joules
kWh	Kilowatt hours
TWh	Terawatt hours
W/m^2K	U-value

LIST OF ABBREVIATIONS

AC	Alternating Current
ASEAN	Association of Southeast Asian Nations
CO_2	Carbon dioxide
DC	Direct Current
ECHO IV	4^{th} Electronic Computing Home Operator
EHR	Electronic health record
ESP	Enforced Sub Populations algorithm
GHG	Greenhouse gas
GSM	Global System for Mobile Communications
IDTV	Interactive Digital TV
IEA	International Energy Agency
IHU	Intelligent hardware units
IoT	Internet of Things
LCEA	Life cycle energy assessment
MHP	Multimedia Home Platform
OAP	Open Access Plan
OSGi	Open Source Gateway Initiative
OWL	Ontology Web Language
OWL-OS	OWL-OSGi
PIR	Passive Infra-Red
PLC	Programmable Logic Controller
PMV	Present Market Value
RF	Radio Frequency
RIDE	Robotics Integrated Development Environment
SHEMS	Smart Home Energy Management System
SI	International System of Units
SMS	Short Messaging System
SPI	Serial Peripheral Interface
WHAS	Wireless Home Automation System

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